EL169835308

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PTO/SB/05 (12/97)
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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	MI22-1017
Total Pages	52
First Named Inventor or Application Identifier	Anand Srinivasan et al.
Express Mail Label No.	EL169835308

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Assistant Commissioner for Patents**
Box Patent Application
Washington, DC 20231

1. [X] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification *(preferred arrangement set forth below)* [*Total Pages* 20]
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [ ] Drawing(s) *(35 USC 113)* [*Total Sheets*]
4. Oath or Declaration [*Total Pages* 3]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [X] Assignment Papers (cover sheet & document(s))
9. [X] 37 CFR 3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [X] Information Disclosure Statement (IDS)/PTO-1449 [X] Copies of IDS Citations
12. [ ] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [X] Other: Check

17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: ____________

18. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* *(Insert Customer No. or Attach bar code label here)* or [X] *Correspondence address below*

NAME	David G. Latwesen, Ph.D.				
ADDRESS	Wells, St. John, Roberts, Gregory & Matkin P.S. W. 601 First Ave., Suite 1300				
CITY	Spokane	*STATE*	WA	*ZIP CODE*	99201-3828
COUNTRY		*TELEPHONE*	(509) 624-4276	*FAX*	(509) 838-3424

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FEE TRANSMITTAL

Note Effective October 1, 1997.
Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT ($) 1,466

Complete if Known	
Application Number	Filed Concurrently
Filing Date	
First Named Inventor	Anand Srinivasan etal
Group Art Unit	
Examiner Name	Unassigned
Attorney Docket Number	MI22-1017

METHOD OF PAYMENT (check one)

1. [X] The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number: 23-0925

Deposit Account Name: Wells, St. John, Roberts et al.

[X] Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

[ ] Charge the Issue Fee Set in 37 CFR 1.18 at the Mailing of the Notice of Allowance

2. [ ] Payment Enclosed:
[ ] Check [ ] Money Order [ ] Other

FEE CALCULATION

1. FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	790
106	330	206	165	Design filing fee	
107	540	207	270	Plant filing fee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 790

2. CLAIMS

			Extra		Fee from below		Fee Paid
Total Claims	34	-20 =	14	X	22	=	308
Independent Claims	7	- 3 =	4	X	82	=	328
Multiple Dependent Claims			0	X	270	=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	22	203	11	Claims in excess of 20
102	82	202	41	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim
109	82	209	41	Reissue independent claims over original patent
110	22	210	11	Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 636

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	0
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	0
139	130	139	130	Non-English specification	0
147	2,520	147	2,520	For filing a request for reexamination	0
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	0
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	0
115	110	215	55	Extension for reply within first month	0
116	400	216	200	Extension for reply within second month	0
117	950	217	475	Extension for reply within third month	0
118	1,510	218	755	Extension for reply within fourth month	0
128	2,060	228	1,030	Extension for reply within fifth month	0
119	310	219	155	Notice of Appeal	0
120	310	220	155	Filing a brief in support of an appeal	0
121	270	221	135	Request for oral hearing	0
138	1,510	138	1,510	Petition to institute a public use proceeding	0
140	110	240	55	Petition to revive - unavoidable	0
141	1,320	241	660	Petition to revive - unintentional	0
142	1,320	242	660	Utility issue fee (or reissue)	0
143	450	243	225	Design issue fee	0
144	670	244	335	Plant issue fee	0
122	130	122	130	Petitions to the Commissioner	0
123	50	123	50	Petitions related to provisional applications	0
126	240	126	240	Submission of Information Disclosure Stmt	0
581	40	581	40	Recording each patent assignment per property (times number of properties)	40
146	790	246	395	Filing a submission after final rejection (37 CFR 1.129(a))	0
149	790	249	395	For each additional invention to be examined (37 CFR 1.129(b))	0
				Other fee (specify) ______	0
				Other fee (specify) ______	0

* Reduced by Basic Filing Fee Paid

SUBTOTAL(3) ($) 40

SUBMITTED BY				Complete (if applicable)	
Typed or Printed Name	[signature]			Reg. Number	38533
Signature	David G. Latwesen, Ph.D.	Date	9/3/98	Deposit Account User ID	

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EL169835308

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

*   *   *   *   *

METHODS OF FORMING INSULATING MATERIALS

*   *   *   *   *

INVENTORS

Anand Srinivasan
Gurtej Sandhu
Ravi Iyer

ATTORNEY'S DOCKET NO. MI22-1017

Methods of Forming Insulating Materials

TECHNICAL FIELD

The invention pertains to methods of forming insulating materials, such as, for example, materials comprising silicon oxide. In exemplary applications, the invention pertains to methods of forming boron and/or phosphorous doped materials comprising fluorine, silicon and oxygen.

BACKGROUND OF THE INVENTION

Silicon oxide materials (such as, for example, silicon dioxide) are commonly used in semiconductor device fabrication as insulating materials. Silicon oxide materials can be formed by chemical vapor deposition (CVD) from appropriate precursors. An exemplary combination of precursors that can be utilized for forming silicon oxide materials is silane (SiH_4) and hydrogen peroxide (H_2O_2). Another precursor combination which can be utilized for forming silicon oxides is tetraethyl orthosilicate (TEOS) and ozone (O_3).

Silicon oxide materials can be doped with one or both of boron and phosphorous to alter (lower) a dielectric constant of the material. The boron and/or phosphorous can be introduced into a silicon oxide material by, for example providing one or both of a boron-containing precursor material and a phosphorous precursor material in a CVD reaction chamber during deposition of the silicon oxide material.

Suitable phosphorous precursor materials include, for example, PH_3 and tetraethoxy phosphine (TEPO). Suitable boron-containing precursors include, for example, B_2H_6 and triethyl borane (TEB). An alternative method of introducing phosphorus and/or boron into a silicon oxide material is to implant one or both of phosphorus and boron into the material.

A characteristic of a deposited silicon oxide material is its so-called flow temperature. A flow temperature is a temperature at which the silicon oxide material will melt. Flow temperature can be an important characteristic of silicon oxide materials. For instance, incorporation of silicon oxide materials into semiconductor fabrication processes frequently involves melting and reflowing of the materials to increase planarity and obtain good coverage of the materials over underlying device structures. Films consisting essentially of silicon dioxide typically have flow temperatures of about 1,100°C or higher. Addition of boron or phosphorous to such films can reduce the flow temperatures to less than 850°C. It would be desirable to further reduce flow temperatures. Specifically, silicon oxide flow frequently occurs after provision of semiconductor devices in a semiconductor fabrication process. The high temperatures of silicon dioxide reflow can adversely affect such devices.

Another characteristic of silicon oxide materials is density. Denser materials generally have better flow properties than less dense materials.

Specifically, denser materials can frequently reflow over underlying nonplanar structures more quickly than can less dense silicon oxide materials. Accordingly, it would be desirable to develop methods for densifying silicon oxide materials.

SUMMARY OF THE INVENTION

In one aspect, the invention encompasses a method of forming an insulating material. A substrate is provided within a reaction chamber together with reactants comprising Si, F and ozone. An insulating material comprising fluorine, silicon and oxygen is deposited onto the substrate from the reactants.

In another aspect, the invention encompasses a method of forming a boron-doped silicon oxide having Si-F bonds. A substrate is provided within a reaction chamber together with reactants comprising F-TES, a boron-containing precursor, and ozone. A boron-doped silicon oxide having Si-F bonds is deposited onto the substrate from the reactants.

In yet another aspect, the invention encompasses a method of forming a phosphorus-doped silicon oxide having Si-F bonds. A substrate is provided within a reaction chamber together with reactants comprising F-TES, a phosphorus-containing precursor, and ozone. A phosphorus-doped silicon oxide having Si-F bonds is deposited onto the substrate from the reactants.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

The invention encompasses methods of chemical vapor deposition of insulating materials comprising fluorine, silicon and oxygen. In one aspect, the invention encompasses a method wherein a substrate is provided within a CVD reaction chamber together with reactants comprising Si, F and ozone. Subsequently, an insulating material comprising fluorine, silicon and oxygen is deposited onto the substrate from the reactants.

In an exemplary embodiment of the invention, the Si and F are comprised by a compound having an Si-F bond, such as, for example F-TES (triethoxy fluorosilane). The F-TES is preferably flowed into the reaction chamber at a rate from about 100 milligrams per minute (mg/min) to about 500 mg/min. The ozone is preferably flowed into the reaction chamber as a mixture with O_2 (the mixture preferably containing from about 5% to about 15% ozone, by volume), with an example being at a rate from about 1000 standard cubic centimeters per minute (sccm) to about 5000 sccm, and preferably about 2000 sccm. In addition to the F-TES and ozone, a second silicon precursor can be flowed into the reaction chamber. Such second silicon precursor can comprise, for example, TEOS. In alternative embodiments of the

invention, the Si reactants can comprise TEOS and the F reactants can be comprised by molecules lacking Si.

Temperature of the substrate within the reaction chamber is preferably maintained at from about 400°C to about 700°C, and more preferably maintained at about 500°C. Pressure within the reaction chamber is preferably maintained at from about 1 Torr to about 1 atmosphere, more preferably at from about 600 Torr to about 1 atmosphere, and even more preferably at about 400 Torr. Most preferably, no plasma is present within the CVD reaction chamber to reduce costs and process complexity. However, it is noted that the invention encompasses embodiments wherein plasma is present within the reaction chamber during the deposition process.

Under the above-described exemplary conditions, a material comprising fluorine, silicon and oxygen is deposited onto the substrate at a rate from about 500 Å/minute to about 10,000 Å/minute, and is typically deposited at a rate of about 8,000 Å/minute. The deposited material comprises silicon oxide interspersed with Si-F bonds. The fluorine is generally present in such material to a concentration from about 0.1 atomic percent to about 10 atomic percent.

An advantage of incorporating fluorine into a silicon oxide material is that the fluorine can reduce the flow temperature of the material. For instance, it is found that fluorine incorporation into a silicon oxide material to an amount of from about 0.1 atomic percent

to about 10 atomic percent can reduce a flow temperature of the material. Specifically, it is found that a flow temperature of the material can be reduced by from about 50°C to about 100°C relative to a silicon oxide material that is identical to the fluorine-containing material in all respects except for lacking the fluorine.

Another advantage of incorporating Si-F bonds into a silicon oxide material (such as, for example, SiO_2 or borophosphosilicate glass) is that the fluorine can decrease a dielectric constant of the material.

Yet another advantage of incorporating fluorine into a silicon oxide material can be to reduce so-called fixed charge problems. Fixed charges result when one or more silicon atoms are bonded to less than four other atoms. In such circumstances, the silicon atoms can carry positively-charged electron density and shift a threshold voltage of a device incorporating the silicon atoms. Negatively charged fluorine atoms can interact with the positively-charged electron density to neutralize the density and alleviate fixed charge problems that would otherwise occur.

It is noted that F-TES has been utilized in the prior art in CVD processes for depositing silicon oxide materials. However, the F-TES was not utilized in combination with ozone. An aspect of the present invention is recognition that chemical vapor deposition of fluorine-containing silicon oxide from reactants comprising F-TES can be significantly improved if such reactants further comprise ozone.

Specifically, it is recognized that if the reactants comprise F-TES and lack ozone, very little fluorine is incorporated into a deposited silicon oxide. The advantageous effects of ozone have not been seen with other oxygen-containing precursors. Specifically, it is found that O_2 and/or H_2O_2 work significantly less well than ozone as co-reactants with F-TES. In other words, if a comparable concentration of H_2O_2 or O_2 is utilized under the above-described reaction conditions in substitution of ozone, the silicon oxide that is formed will have significantly less than 0.1 atomic percent fluorine incorporated therein. Such silicon dioxide will have higher flow temperatures and less density than a preferred silicon oxide formed according to a method of the present invention utilizing ozone in a chemical vapor deposition process. Also, H_2O_2 can be more difficult to work with than ozone. For instance, it can be more difficult to accurately control an H_2O_2 concentration in a reaction chamber than to control an ozone concentration in the chamber.

In other aspects of the invention, a fluorine-containing silicon oxide can be provided to be doped with, for example, one or both of phosphorous and boron. For instance, a phosphorous precursor can be incorporated as a reactant in a chemical vapor deposition process of the present invention to form an insulating material comprising fluorine, silicon, oxygen, and phosphorous. The phosphorous precursor can comprise, for example, TEPO. Preferably, the amount of phosphorous

incorporated into a fluorine-containing silicon oxide of the present invention is from about 1 atomic percent to about 10 atomic percent.

Exemplary conditions for incorporating phosphorous into a fluorine-containing silicon oxide utilizing a CVD process include:

a pressure within a CVD reaction chamber of from about 1 Torr to about 1 atmosphere;

a temperature of a substrate within the chamber of from about 400°C to about 700°C;

a flow rate of F-TES into the reaction chamber of from about 100 mg/min to about 500 mg/min;

a flow rate of ozone-containing gas (provided as a mixture of from about 5% to about 15% ozone in O_2) of from about 1000 sccm to about 5000 sccm; and

a flow rate of TEPO in the reaction chamber of from about 25 mg/min to about 400 mg/min.

As another example, boron can be incorporated into a fluorine-containing silicon oxide of the present invention by providing a boron-containing precursor as a reactant in a CVD reaction chamber. The boron-containing precursor can comprise, for example, TEB. The boron is preferably provided in a fluorine-containing silicon oxide of the present invention to a concentration of from about 1 atomic percent to about 10 atomic percent, and more preferably provided to a concentration of less than or equal to about 8 atomic percent.

An exemplary process for incorporating boron into a fluorine-containing silicon oxide utilizing a CVD process includes:

a pressure within a CVD reaction chamber of from about 1 Torr to about 1 atmosphere;

a temperature of a substrate within the chamber of from about 400°C to about 700°C;

a flow rate of F-TES into the reaction chamber of from about 100 mg/min to about 500 mg/min;

a flow rate of ozone-containing gas (provided as a mixture of from about 5% to about 15% ozone in O_2) of from about 1000 sccm to about 5000 sccm; and

a flow rate of TEB into the reaction chamber of from about 25 mg/min to about 400 mg/min.

In yet another exemplary application, a fluorine-containing silicon oxide of the present invention can be provided to be doped with both boron and phosphorous. Preferably, the boron and phosphorous atoms are together provided to a concentration of from about 3 atomic percent to about 12 atomic percent within the fluorine-containing silicon oxide. An exemplary composition of the silicon oxide comprises about 3% boron, about 7% phosphorous, and about 2% fluorine (by atomic percent).

Exemplary conditions for forming the boron and phosphorous doped fluorine-containing silicon oxide include:

a pressure within a CVD reaction chamber of from about 1 Torr to about 1 atmosphere;

a temperature of a substrate within the chamber of from about 400°C to about 700°C;

a flow rate of F-TES into the reaction chamber of from about 100 mg/min to about 1000 mg/min;

a flow rate of ozone-containing gas (provided as a mixture of from about 5% to about 15% ozone in O_2) of from about 1000 sccm to about 8000 sccm;

a flow rate of TEPO in the reaction chamber of from about 25 mg/min to about 400 mg/min; and

a flow rate of TEB into the reaction chamber of from about 25 mg/min to about 400 mg/min. In preferred embodiments, the pressure is from about 10 Torr to about 700 Torr.

In each of the above-described embodiments, the CVD reaction chamber referred to is a single wafer, cold wall chamber. The invention encompasses embodiment utilizing other types of reaction chambers.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or

modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS:

1. A method of forming an insulating material comprising:

providing a substrate within a reaction chamber;

providing reactants comprising silicon, fluorine and ozone within the reaction chamber; and

depositing an insulating material comprising fluorine, silicon and oxygen onto the substrate from the reactants.

2. The method of claim 1 wherein the depositing occurs without a plasma being present in the reaction chamber.

3. The method of claim 1 wherein the depositing occurs with a plasma being present in the reaction chamber.

4. The method of claim 1 wherein the silicon and fluorine of the reactants are comprised within a common molecule.

5. The method of claim 1 wherein the silicon and fluorine of the reactants are comprised within a common molecule having an Si-F bond.

6. The method of claim 1 wherein the silicon and fluorine of the reactants are comprised by triethoxy fluorosilane.

7. The method of claim 1 wherein the fluorine in the insulating material is present in Si-F bonds.

8. The method of claim 1 wherein the fluorine in the insulating material is present at a concentration of from about 0.1 atomic percent to about 10 atomic percent.

9. The method of claim 1 wherein the insulating material is deposited at a rate of from about 1000 Å/minute to about 7000 Å/minute.

10. The method of claim 1 further comprising maintaining a pressure within the reaction chamber at from about 1 Torr to about 1 atmosphere during the depositing.

11. The method of claim 1 further comprising maintaining a pressure within the reaction chamber at from greater than 400 Torr to about 1 atmosphere during the depositing.

12. The method of claim 1 further comprising maintaining a temperature of the substrate at from about 400°C to about 700°C during the depositing.

13. The method of claim 1 wherein the reactants further comprise phosphorus, and wherein the insulating material comprises fluorine, silicon, oxygen and phosphorus.

14. The method of claim 1 wherein the reactants further comprise boron, and wherein the insulating material comprises fluorine, silicon, oxygen and boron.

15. The method of claim 1 wherein the reactants further comprise boron and phosphorus, and wherein the insulating material comprises fluorine, silicon, oxygen, boron and phosphorus.

16. The method of claim 1 wherein the reactants comprise a molecule that includes both Si and F, and another molecule that includes Si without F.

17. The method of claim 1 wherein the reactants comprise triethoxy fluorosilane and tetraethyl orthosilicate.

18. A method of forming a silicon oxide having Si-F bonds, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising ozone and a precursor having Si-F bonds; and

depositing a silicon oxide having Si-F bonds onto the substrate from the reactants.

19. The method of claim 18 wherein the precursor having Si-F bonds is triethoxy fluorosilane.

20. The method of claim 18 wherein the depositing occurs without a plasma being present in the reaction chamber.

21. A method of forming a boron-doped silicon oxide having Si-F bonds, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising triethoxy fluorosilane, a boron-containing precursor, and ozone within the reaction chamber; and

depositing a boron-doped silicon oxide having Si-F bonds onto the substrate from the reactants.

22. The method of claim 21 wherein the boron-containing precursor is triethyl borane.

23. A method of forming a phosphorus-doped silicon oxide having Si-F bonds, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising triethoxy fluorosilane, a phosphorus-containing precursor, and ozone within the reaction chamber; and

depositing a phosphorus-doped silicon oxide having Si-F bonds onto the substrate from the reactants.

24. The method of claim 23 wherein the phosphorus-containing precursor is tetraethoxy phosphine.

25. A method of forming a boron and phosphorus doped silicon oxide having Si-F bonds, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising triethoxy fluorosilane, a boron-containing precursor, a phosphorus-containing precursor and ozone within the reaction chamber; and

depositing a boron and phosphorus doped silicon oxide having Si-F bonds onto the substrate from the reactants, the depositing occurring without a plasma being present in the reaction chamber.

26. The method of claim 25 wherein the boron-containing precursor is triethyl borane.

27. The method of claim 25 wherein the phosphorus-containing precursor is tetraethoxy phosphine.

28. The method of claim 25 wherein the phosphorus-containing precursor is tetraethoxy phosphine and the boron-containing precursor is triethyl borane.

29. A method of forming a silicon and oxygen containing insulating material having reduced flow temperatures, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising Si, F and ozone within the reaction chamber; and

depositing a first insulating material containing fluorine, silicon and oxygen onto the substrate from the reactants, the first insulating material having reduced flow temperatures as compared to another silicon and oxygen containing insulating material deposited under the same conditions but without having fluorine in the reactants.

30. The method of claim 29 wherein reactants further comprise at least one of a phosphorus-containing precursor and a boron-containing precursor, and wherein the first insulating material further comprises at least one of boron and phosphorus.

31. The method of claim 29 wherein the Si and F are comprised by triethoxy fluorosilane.

32. A method of forming a silicon and oxygen containing insulating material having increased density, comprising:

providing a substrate within a reaction chamber;

providing reactants comprising Si, F and ozone within the reaction chamber; and

depositing a first insulating material containing fluorine, silicon and oxygen onto the substrate from the reactants, the first insulating material having increased density as compared to another silicon and oxygen containing insulating material deposited under the same conditions but without having fluorine in the reactants.

33. The method of claim 32 wherein reactants further comprise at least one of a phosphorus-containing precursor and a boron-containing precursor, and wherein the first insulating material further comprises at least one of boron and phosphorus.

34. The method of claim 32 wherein the Si-F precursor is triethoxy fluorosilane.

ABSTRACT OF THE DISCLOSURE

In one aspect, the invention includes a method of forming an insulating material comprising: a) providing a substrate within a reaction chamber; b) providing reactants comprising a Si, F and ozone within the reaction chamber; and c) depositing an insulating material comprising fluorine, silicon and oxygen onto the substrate from the reactants. In another aspect, the invention includes a method of forming a boron-doped silicon oxide having Si-F bonds, comprising: a) providing a substrate within a reaction chamber; b) providing reactants comprising Triethoxy fluorosilane, a boron-containing precursor, and ozone within the reaction chamber; and c) depositing a boron-doped silicon oxide having Si-F bonds onto the substrate from the reactants. In yet another aspect, the invention includes a method of forming a phosphorus-doped silicon oxide having Si-F bonds, comprising: a) providing a substrate within a reaction chamber; b) providing reactants comprising triethoxy fluorosilane, a phosphorus-containing precursor, and ozone within the reaction chamber; and c) depositing a phosphorus-doped silicon oxide having Si-F bonds onto the substrate from the reactants.

EL169835308

DECLARATION OF JOINT INVENTORS FOR PATENT APPLICATION

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: Methods of Forming Insulating Materials, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

PRIOR FOREIGN APPLICATIONS:

I hereby state that no applications for foreign patents or inventor's certificates have been filed prior to the date of execution of this declaration.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under

Section 1001 of Title 18 of the United States Code and that such willful false statement may jeopardize the validity of the application or any patent issued therefrom.

* * * * * * * * * *

Full name of inventor: Anand Srinivasan

Inventor's Signature: ________________

Date: 9/3/98

Residence: Boise, ID

Citizenship: India

Post Office Address: 670 S. Clearwater, #201
Boise, ID 83712

* * * * * * * * * *

Full name of inventor: Gurtej Sandhu

Inventor's Signature: Gurtej Singh Sandhu

Date: 9/3/98

Residence: Boise, ID

Citizenship: Great Britain

Post Office Address: 2964 E. Parkriver Drive
Boise, ID 83706

* * * * * * * * * *

Full name of inventor: **Ravi Iyer**

Inventor's Signature: ______________________

Date: 9/3/98

Residence: **Boise, ID**

Citizenship: **India**

Post Office Address: **5600 S. Fuchsia Ln.**
Boise, ID 83716

EL169835308

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. .... Filed herewith
Filing Date .... Filed herewith
Inventor .... Anand Srinivasan et. al.
Assignee .... Micron Technology, Inc.
Group Art Unit .... Unknown
Examiner .... Unknown
Attorney's Docket No. MI22-1017
Title: Methods Of Forming Insulating Materials

POWER OF ATTORNEY BY ASSIGNEE AND CERTIFICATE BY ASSIGNEE UNDER 37 CFR §3.73(b)

To: Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

MICRON TECHNOLOGY, INC., the Assignee of the entire right, title and interest in the above-identified patent application by assignment attached hereto, hereby appoints the attorneys and agents of the firm of WELLS, ST. JOHN, ROBERTS, GREGORY & MATKIN P.S., listed as follows:

Richard J. St. John	Reg. No. 19,363
David P. Roberts	Reg. No. 23,032
Randy A. Gregory	Reg. No. 30,386
Mark S. Matkin	Reg. No. 32,268
James L. Price	Reg. No. 27,376
Deepak Malhotra	Reg. No. 33,560
Mark W. Hendricksen	Reg. No. 32,356
David G. Latwesen	Reg. No. 38,533
George G. Grigel	Reg. No. 31,166
Keith D. Grzelak	Reg. No. 37,144
John S. Reid	Reg. No. 36,369
Lance R. Sadler	Reg. No. 38,605
James D. Shaurette	Reg. No. 39,833

and also attorneys Michael L. Lynch (Reg. No. 30,871) and Lia Pappas Dennison (Reg. No. 34,095) of Micron Technology, Inc., as its attorneys with full power of substitution to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

The Assignee certifies that the above-identified Assignment has been reviewed and to the best of Assignee's knowledge and belief, title is in the Assignee.

Please direct all correspondence regarding this application to:

Wells, St. John, Roberts, Gregory & Matkin P.S.
Attn: David G. Latwesen, Ph.D.
601 W. First Avenue, Suite 1300
Spokane, WA 99201-3828

Telephone: (509) 624-4276
Facsimile: (509) 838-3424

MICRON TECHNOLOGY, INC.

Dated: 9/3/98 By: [signature]

Name: Michael L. Lynch, Esq.
Title: Chief Patent Counsel